The Putrajaya Wetland Project

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Introduction

Putrajaya, Malaysia's new Federal Government Administrative Centre is being developed as an intelligent city and city in a garden. Central to this city in a garden concept is the 400 hectare man-made lake created by damming of Sg. Chuau and Sg. Bisa. The resulting lake (shown in Figure 3) forms the centrepiece of the new city giving it a distinctive character and identity. In order to ensure that the water entering the lake is clean and suitable for body contact recreational activities, an environmentally friendly approach by constructing a series of wetlands to treat the catchment runoff before it enters Putrajaya Lake was adopted by Perbadanan Putrajaya.

This is the first man-made wetlands undertaken in Malaysia. Construction of the Putrajaya wetlands began in March 1997 and was completed in August 1998. The wetlands was constructed using predominantly local resources. Over 90% of the materials used were sourced locally. The successful implementation of the wetland project is an important step towards realising its goals. This article provides a brief introduction of design of Putrajaya wetlands for stormwater pollution control.

Goals of the Wetland Project

The wetland project has a set of defined goals. They are:

- to create a self-sustaining and balanced lake ecosystem;
- to ensure the lake's water quality complies with standard set by Perbadanan Putrajaya and suitable for body contact recreational activities;
- to construct a wetland ecosystem that is unique to this part of the world;
- to develop a natural habitat for conservation of indigenous wetland flora and fauna;
- to establish an environment suitable for public education and scientific research on wetlands;
- to develop an aesthetically pleasing environment that enhances quality of life in Putrajaya and makes the city an attractive destination for domestic and international tourism.

General Information

The Putrajaya Wetland involves an area of 197 hectares and 12.3 million wetland plants, is one of the largest fully constructed freshwater wetlands in the tropics. The project resulted in transforming an oil palm plantation site into a wetland ecosystem. The wetlands are strategically located to act as buffer to the Putrajaya Lake which drains a catchment area of 50.9 km^2. They straddle the water courses of Sg. Chuau, Sg. Bisa and three tributaries.

Figure 1 shows the location of the six wetland systems. The size and storage capacity of the wetlands are shown in figure 2.

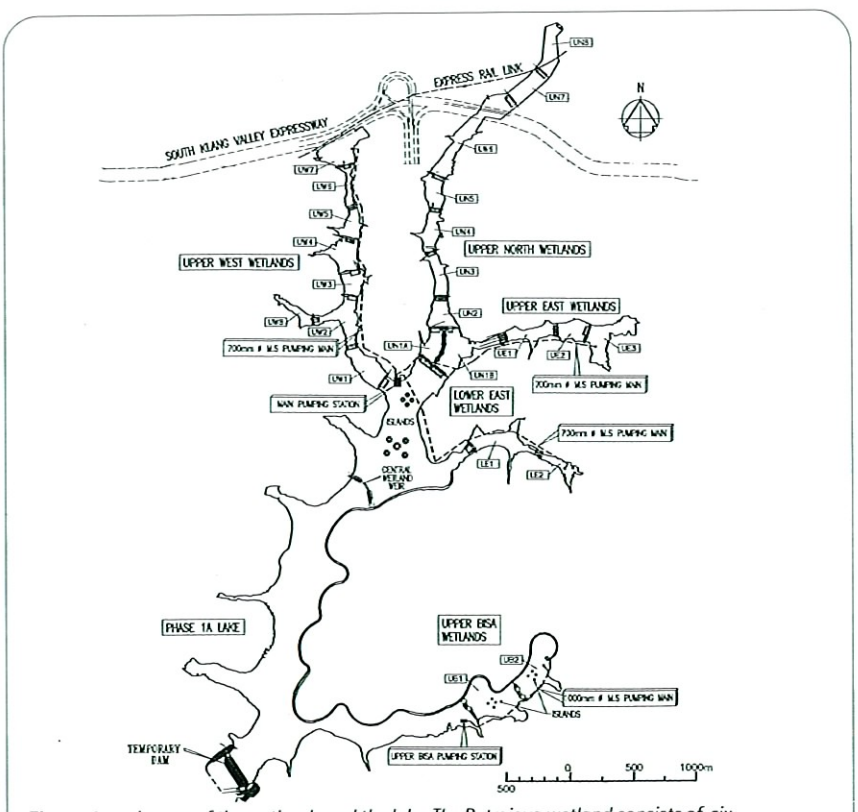
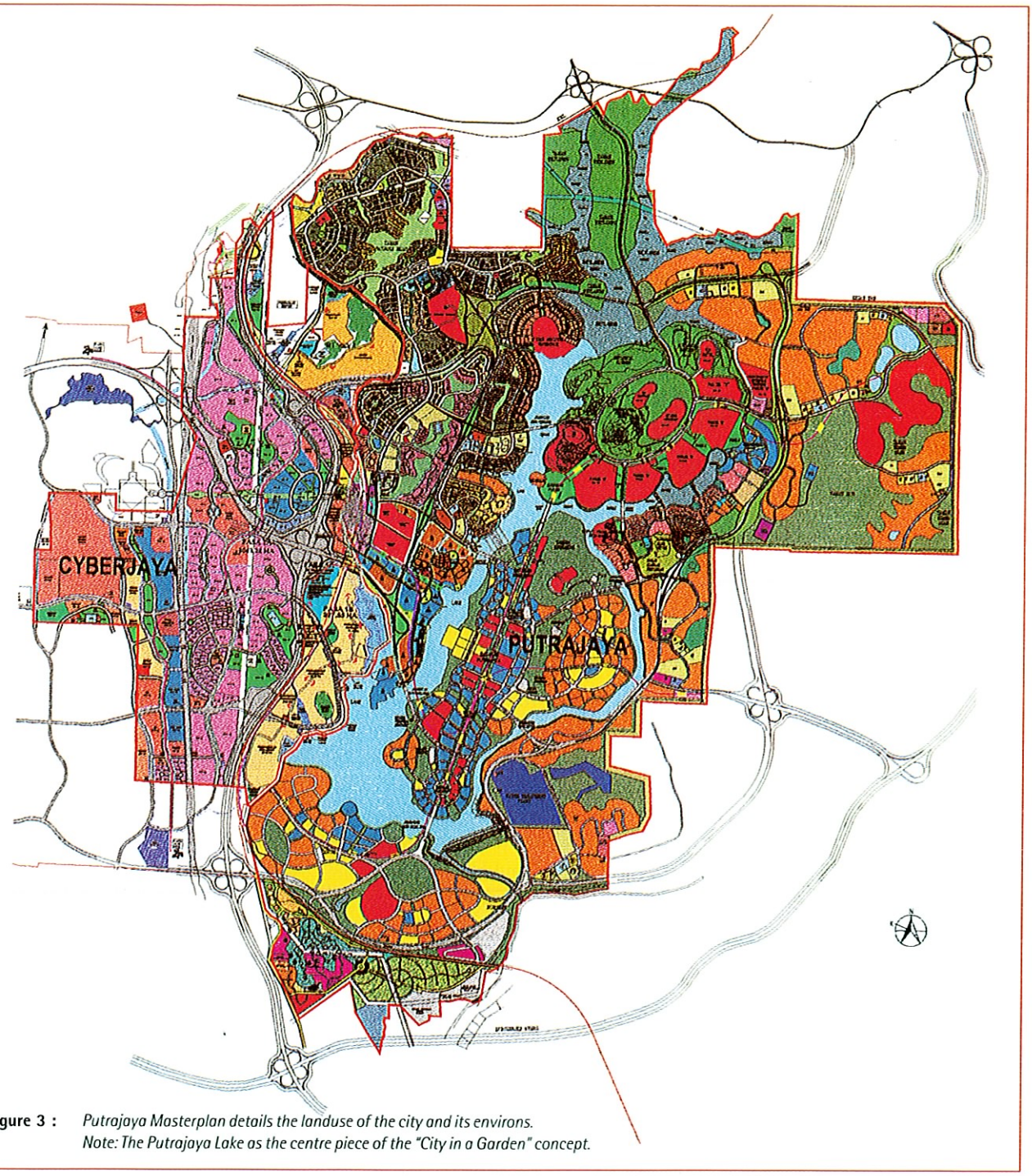


Figure 1 : *Layout of the wetlands and the lake. The Putrajaya wetland consists of six wetland systems with 24 cells.*



gure 3 : *Putrajaya Masterplan details the landuse of the city and its environs.*
Note: The Putrajaya Lake as the centre piece of the "City in a Garden" concept.

gure 2

Wetland System	Upper North	Upper West	Upper East	Lower East	Upper Bisa	Central Wetlands
chment Area (Km²)	11.54	5.53	3.34	1.73	4.03	24.7

The Wetland Design

The design of the wetland system involved study of the catchment conditions i.e. terrain, drainage, geology and soils, meteorology, hydrology,

of determining the size and layout of the wetlands required by simulating the future development conditions of Putrajaya to ascertain that the performance of the wetlands met the desired water quality standard.

The wetlands are designed to achieve retention and removal of a range of catchment pollutants, which includes nutrients and other contaminants such as trace metals, BOD and COD transported in either particulate, colloidal or soluble form.

Phosphorus is a critical parameter as it is a difficult chemical to be retained in the wetlands and will result in eutrophication of the lake if excess amounts are not removed. The long term pollutant export and retention for the Putrajaya wetlands and lake systems is simulated using the water quality model i.e. AQUALM to assess the eutrophication potential of the lake subject to the designed pollutant loading rates.

The general view of the constructed wetlands at Upper West, Lower East and Central Wetlands. (from top to bottom)

The design of the wetlands involved shaping of wetland morphology, sizing and layout of wetlands, design of hydrologic and hydraulic controls, vegetation selection and plant layout which govern the overall level of performance of the wetlands.

The existing terrain at the site is undulating which requires extensive reshaping to create a wetland morphology suitable for plant establishment and hydraulic performance. A series of rockfilled weirs (24 numbers) is constructed along Sg. Chuau and its main tributaries which divide the area into 24 compartments or cells.

The wetlands are designed as multi-cells and multi-stage units. The multi-cells design has the advantage in achieving a better distribution of flow velocity and maximise shallow areas required for planting of macrophytes. It also improves accessibility for maintenance purposes. The multi-stage design improves the hydraulic performance by providing an extended detention storage for flood attenuation above permanent pool to extend the treatment capacity and hence reduces the hydraulic and pollutant overload during high flows.

Wetland Components

The wetland system generally comprises a combination of vegetated area and open water. A river inlet zone is constructed at the head of each wetland system which serves to intercept incoming flows. It is lined with armoured rock to dessipate energy, reduce flow velocity and distribute it laterally over the sedimentation basin.

Primary sedimentation basins are provided to allow settling of heavier fraction of incoming sediment load where desilting can be carried out at intervals approximately 3 to 5 years. Trash racks and gross pollutant traps in this zone are provided to remove litter and other gross solids.

Each wetland cell incorporates the following zones:-

- macrophytes zone (0.3m to 1.0m deep) to enhance sedimentation and filtration by the vegetation, removal of dissolved pollutants by chemical and biological adsorption, facilitate oxygenation of the substracts.
- Open Water Zone (1.0-3.0 deep) to facilitate settlement of coarse sediment, traps adsorbed pollutants, attenuate and distribute inflows to macrophytes zone, expose water to ultra violet light for disinfection.
- Outlet zone to control water level in the cell and rate of discharge from the cell.
- Intermittently flooded zone up to 1.5m above the normal water level of the cell. They are not key treatment component of the wetland but are important for recreational landscape link to adjacent developments.

The macrophyte zones consist of shallow marsh (water depth ~ 0.3m), marsh (water depth ~ 0.6m), deep marsh (water depth ~ 1.0m). The macrophytes zones are relatively tranquil part of the wetlands within which particle settling and adhesion to vegetation occurs. These zones are planted with rooted emergent macrophytes and are the primary nutrient uptake zone. Most commonly used macrophytes are Fimbristylis miliacea, Eleocharis variegata, Polygonum barbatum, Eleocharis dulcis, Scirpus mucronatus, Scirpus grossus, Lepironia articulata and Phragmites karka. All together 12.3 million wetland plants with over 70 species are propagated and planted at the Putrajaya wetland.

Indigenous fishes, including those feed on mosquito larvae, such as pelaga (Beta pugnax) and sepat siam (Trichogester pectoralis), were introduced into the wetlands for control of mosquito.

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